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Slow and steady motion draws power from the wind

by Claire Eamer

"If we didn't have sun, we would never have wind," says Jean-Paul Pinard, a Whitehorse consultant specializing in wind energy.

Like most energy on Earth, wind energy originally comes from the sun. Sunlight transfers energy into the earth's atmosphere in the form of warmth, but the warmth is distributed unevenly, Pinard says, and the result is wind.

Air at the equator, where the sun's light is most direct, becomes warmer than air at the poles. The lighter warm air rises, cooler air from the directions of the poles flows in below it, and the warm air flows toward the poles to replace the cool air. That movement of air, the wind, is energy captured from the sun -- and energy that we can capture in turn.

In this new-generation wind generator in Australia, the rotor is connected directly to the generator with a single shaft. The generator (the large round plate right behind the rotor) is larger than in earlier designs so that it can spin more slowly without losing generating capacity.

(photo: Claire Eamer)

The recipe is simple, says Pinard: "Wind is a gas. It contains mass. That mass in motion contains energy."

Wind generators, like those on Haeckel Hill near Whitehorse, turn the energy of moving gas into electricity. Again, as Pinard explains it, the process is essentially simple.

Passing a magnet over a wire dislodges some electrons and causes them to flow through the wire. The flow of electrons through a material is the essence of electricity.

In a wind generator, moving air pushes on the blades of the rotor, causing it to rotate. The rotor moves a magnet, or a set of magnets, past coils of wire, inducing an electrical current that can be fed into the main electrical grid through a cable running down inside the generator tower.

In practice, of course, wind generation is not quite so simple. Wind generators like those on Haeckel Hill use gears to transfer the motion of the blades to the speeding up of the generator itself, resulting in a loss of energy through friction. In a more recent generation of wind generators, the rotor is connected directly to a much larger-diameter generator with a single shaft. That means less friction and fewer moving parts to break down or wear out, says Pinard.

Another complicating factor is the fact that the wind moves around and changes speed. The simple pattern of warm air aloft moving toward the poles and cooler air below it moving toward the equator is complicated by factors like the rotation of the earth, oceans and land masses on the earth's surface, and moisture hanging in the air in the form of clouds.

A motor, called a yaw motor, is housed inside the nacelle, the box at the top of the wind generator's tower, Pinard explains. Its main job is to keep the rotor blades facing into the wind at the most efficient angle. It also protects the cable inside the tower. As the rotor turns to face the wind, the cable can become increasingly twisted.

"Eventually it hits a limit, and the yaw motor kicks in and turns the rotor and nacelle around until the cable is untwisted," says Pinard.

The other complication with wind is that it changes speed. If the wind speed is too low, the blades don't turn at all. As the wind speed increases, they turn faster, but within limits.

"When it's windier, the generator is drawing more power and that slows the blades down," says Pinard. However, wind generators also have safeguard systems built in, partly so that the blades don't spin out of control if the generator is disconnected from the grid and partly to keep the rotation speed fairly slow.

"There's a good reason why they keep it slow," Pinard says. "In fact, a couple of good reasons."

One reason is to reduce the risk to birds by making the blades more visible. Equally important is to minimize the effects of vibration on the blades and tower. The faster the blades move, the more stress is placed on the physical structure. In addition, at certain speeds that are related to the length of the blades, the motion can set up strong vibrations that can damage the structure.

Although the rotation of the blades looks fairly slow, especially from a distance, Pinard says the size of the rotors means the tips of the blades are actually moving through the air quite quickly.

On the larger wind generator on Haeckel Hill, with 23-metre blades rotating at about 30 times per minute, the blade tips could be moving through the air as fast as 260 kilometres an hour. Even the 11-metre blades of the smaller wind generator could achieve a speed of about 170 kilometres an hour at the tips, Pinard estimates.

The Haeckel Hill wind generators contribute only a tiny fraction of the electricity in the grid feeding much of the southern Yukon.

"They're there for experimental reasons," Pinard explains.

The information gleaned from them may contribute more substantially to the power needs of other northern communities, particularly small communities currently dependent on expensive imported diesel to generate electricity, Pinard says. Replacing some of that diesel generation with wind energy could reduce both costs and greenhouse gas emissions.

For more information about wind energy, go to www.yukonenergy.ca/services/renewable/wind.